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KOOTENAI NATIONAL FOREST

LIGHTNING FIRE DENSITIES

1960 - 1974

Collin D. Bevins

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KOOTENAI NATIONAL FOREST

LIGHTNING FIRE DENSITIES

(1960 - 1974)

by

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Introduction to Forest Fire Density

Mean annual lightning fire statistics for the Kootenai National Forest are presented in this paper for the fifteen year period from 1960 through 1974. The fire statistics presented are :

lightning fire occurrence (fires/year),

lightning fire occurrence density (fires/million acres/year),

lightning fire acres burned (acres burned/year),

lightning fire acres burned density (acres burned/mm acres/year),

mean lightning fire size (acres), and

median lightning fire size (acres).

The lightning fire statistics are reported for classes within five common forest and site stratifications:

dominant forest cover type (by plurality),

stand management status,

elevation (msl),

aspect class, and

slope steepness (percent).

Forest fire occurrence, as used in the report, is the absolute number of fires occurring within a forest or site class during the fire season. Forest Service administered nonwilderness lands on the Kootenai National Forest, for example, had 971 lightning fires reported from 1960 through 1974, for a mean annual lightning fire occurrence of 64.7 fires per year.

Forest fire occurrence has been the traditional fire statistic available to, and used by, fire planning and management personnel. Yearly summaries of fire occurrence such as the Northern Region's Annual Regional Fire Report have been produced from each year's accumulation of Individual Fire Report (5100-29) forms. The annual reports, prepared by the Fire and

Aviation Management Office, concentrates largely on fire occurrence within established administrative boundaries, and on the types and extent of suppressic forces deployed. Fire occurrence summaries have also been prepared by Barrows (1951) and Barrows, Sandberg, and Hart[1/] addressing fire occurrence by geographic location, forest cover type, elevation band, and aspect and slope class.

The major limitation in using historical fire occurrence for planning purposes is the absence of information on the corresponding acreages over which the fires occurred. The problem is trivial for fire occurrence within administrative boundaries, where acreages are well established. However, acreage estimates have not been readily available for forest cover type and site classes, making flammability (risk and hazard) assessment and comparison between classes, at best, an educated guess. Such assessment can be made only when fire occurrence per unit area and time, or fire density, is known.

Forest fire occurrence density is the forest fire occurrence within a forest or site class normalized by the class's acreage during the fire season. The 971 lightning fires on the Kootenai National Forest occurred over an estimated land area of 2,251,721 acres[2/], for a fifteen year lightning fire occurrence density of 28.7 fires per million acres per year.

The fire occurrence density statistic has a potentially broader application to fire planning and analysis than does the raw fire occurrence number. Use of the density estimate enables direct comparison of fire occurr-

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1/ Lightning Fires in Northern Rocky Mountain Forests. Unpublished final report to USDA Forest Service Intermountain Forest & Range Experiment Station, Northern Forest Fire Laboratory, Fire Meteorology Project, Missoula, Montana. April 1977. 182 pages.

ence and flammability between classes within a forest or site stratification (e.g., between ponderosa pine and Douglas-fir cover types), as well as between classes of different stratifications (e.g., which is more flammable, ponderosa pine stands on all aspects, or south-southwest aspects of all cover types?). The density statistic flags those classes of greatest risk and flammability which may be of special interest in fuels management and fire and forest planning.

The fire occurrence density may also be interpreted as a fire probability estimate. Under the assumption that lightning fires strike randomly throughout the Kootenai National Forest, the probability of a lightning fire starting on any particular forest acre during a single fire season is estimated as

$$28.7 \text{ fires/million acres/year} \times 10^{-6} = 2.87 \times 10^{-5}.$$

The acres burned fire statistic is the absolute number of acres burned within a forest or site class during the fire season. Forest Service administered nonwilderness lands on the Kootenai National Forest averaged 388.3 acres burned annually by lightning fires from 1960 through 1974.

The acres burned density is the absolute number of acres burned within a forest or site class normalized by the class's acreage during the fire season. Again, for Forest Service administered nonwilderness lands within the Kootenai National Forest, the mean annual lightning fire acres burned density from 1960 through 1974 was 172.5 acres burned per million acres per year.

2/ Forest acreage estimates from 1974 Stage 1 inventory as computed by USDA Forest Service's FINSYS subsystem routines TABLES and OUTPUT.

Perhaps the most useful interpretation of the acres burned density is as an expression of the mean percent of land area burned annually. The mean acres burned density of 172.5 indicates 0.01725% of the Kootenai National Forest was burned per annum from 1960 through 1974. Similarly, there was a yearly probability of 1.725×10^{-4} that any given forest acre would burn during the fire season. The inverse of the annual probability of a single acre burning may furthermore be used as an approximation to the fire periodicity, burning cycle, or "burnover" rate of the forest. Under the assumption that lightning fires are randomly distributed throughout the Kootenai National Forest, the mean burnover rate from 1960 through 1974 was 5797 years. That is, it will theoretically take 5797 years for the Kootenai National Forest to burn over completely one time under the 1960 through 1974 fire occurrence and suppression regime. As will become evident in the remainder of the report, however, lightning fires do not occur or burn randomly or uniformly throughout the Kootenai National Forest, but vary significantly between forest and site stratification classes.

Finally, the mean and median fire size is presented for all lightning fires in each forest and site class during the fifteen year period studied. Since over 80% of all lightning fires on the Kootenai National Forest were under one acre in size, an order of magnitude difference often exists beteen mean and median fire sizes for a forest or site class. The mean fire size statistic is more strongly influenced by occassional, large conflagrations than is the median, and the mean is therefore generally larger than the median. The fifteen year mean lightning fire size on the Kootenai National Forest was 6.0 acres. The median fire size was 0.2 acres; at least half of all lightning fires were under 0.2 acres in size.

Study Methods

Individual Fire Report (5100-29) forms from 1960 through 1974 were accessed to determine absolute fire occurrence and size by cover type, stand management status, elevation, aspect, slope steepness, and slope position for the Kootenai National Forest. A total of 2102 fires from all causes were reported during the fifteen year period studied, of which 1338 (64%) were lightning-caused, and 764 (36%) were man-caused. Lightning fires on the Kootenai National Forest administered nonwilderness lands totaled 971 and provide the fire data base used in the study. Table 1 summarizes annual lightning fire occurrence on the Kootenai National Forest by land ownership and wilderness designation classes.

The capability of normalizing raw forest fire occurrence data by acreage estimates to produce fire occurrence densities is a recent benefit of the Northern Region's Forest Inventory / Stand Examination procedure, generally known as "Stage 1 inventory". The sample design used, after Stage and Alley (1972), permit statistically-valid forest-wide estimation of acreage distributions among forest cover type, elevation, aspect, slope steepness, and slope position classes. Forest-wide acreage estimates and variances used in the study were computed via the FINSYS subsystem routines TABLES and OUTPUT. The national system is maintained by the USDA Forest Service at the Fort Collins Computer Center.

The FINSYS system stores and manipulates inventory data from 75 land compartments within the Kootenai National Forest. The compartments were randomly selected with probability proportional to size for inclusion in the Stage 1 inventory. A total of 528 identifiable stands covering 19,525 acres were sampled within the 75 compartments.

Table 1

Annual Lightning Fire Occurrence by Land Designation

Kootenai National Forest

Year	Forest Service	Wilderness Areas	Private Lands	Total Fires
1960	96	2	32	130
1961	110	6	35	151
1962	86	0	24	110
1963	89	2	33	124
1964	43	1	27	71
1965	14	0	5	19
1966	27	1	11	39
1967	97	6	32	135
1968	35	0	8	43
1969	8	0	5	13
1970	143	0	45	188
1971	62	0	22	84
1972	20	0	17	37
1973	78	2	22	102
1974	63	2	27	92
Total	971	22	345	1338

The acreage estimates resulting from the one-time inventory were assumed to have remained constant (or to have changed insignificantly) between cover type, elevation, aspect, slope steepness, and slope position classes throughout the fifteen year period studied. The distribution of forest acres between the three stand management status classes, on the other hand, varied from year to year as a result of forest management activity.

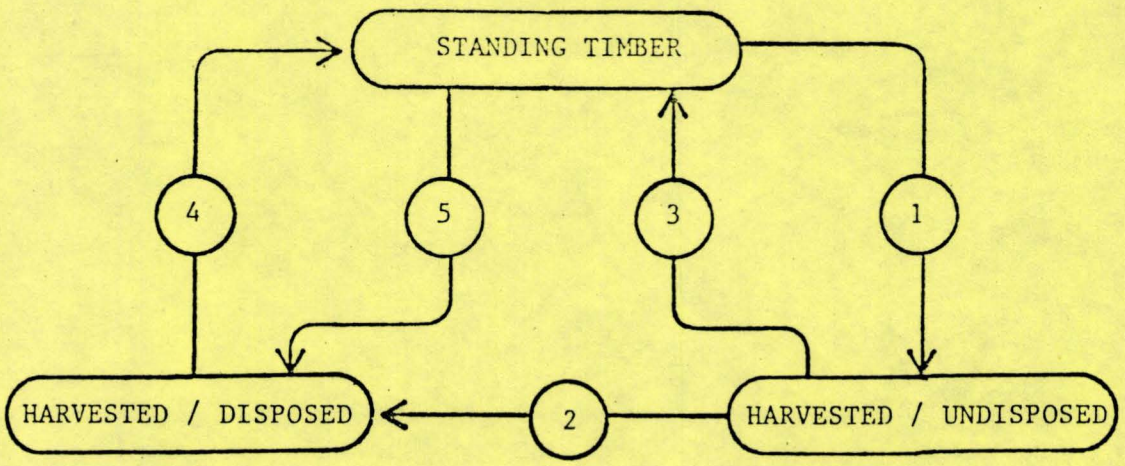
The Northern Region's Stand Examination and Management Status Record (FSH R1 2410-17) was used to determine the yearly distribution of forest acres among the stand management status classes of standing timber, undisposed slash, and disposed (not regenerated) slash sites. The forest management cycle model in Figure 1 was used to exchange acreages between the three classes as a result of five possible management activites as documented by the Stand Examination and Management Status Record; harvests, hazard reduction/site preparation, regeneration following hazard reduction/site preparation, regeneration without previous hazard reduction/site preparation, and wildfire. The Stand Examination and Management Status Record for the Kootenai National Forest contained data on 12,081 stands. Table 2 summarizes acreages transferred by the five management activities and by cover type through 1974.

The fire occurrence data from the 5100-29 forms and acreage estimates from the Stage 1 inventory and Stand Examination and Management Status Record were used to compute fire occurrence density and acres burned density statistics presented in the report. All fire statistics are reported as fifteen year means, and fire occurrence and acres burned densities are in units of millions of acres per year. For a more detailed account of the study methods, the reader is referred to "Derivation of Forest Fire Densities on Northern Region National Forests"[3/].

3/ General technical report in preparation. USDA F.S., Intermtn. For. & Ran.

FIGURE 1

FOREST MANAGEMENT STATUS CYCLE



VECTOR	DESCRIPTION
1	Harvest -- clearcut, shelterwood, seed tree, overstory removal, rehabilitation, select, salvage, and intermediate cuts
2	Hazard Reduction or Site Preparation -- prescribed burning, lopping, jackpot burning, dozer piling and terracing, hand piling, trampling, herbicide spraying, spraying and burning, rolling chopper, machine scarifying, furrowing, and discing, and wildfire
3	Regeneration without Previous Hazard Reduction or Site Preparation
4	Regeneration Following Hazard Reduction or Site Preparation
5	Wildfire -- severe and large enough to be coded as a "harvest or other drain" on the Stand Examination and Management Status record

Table 2

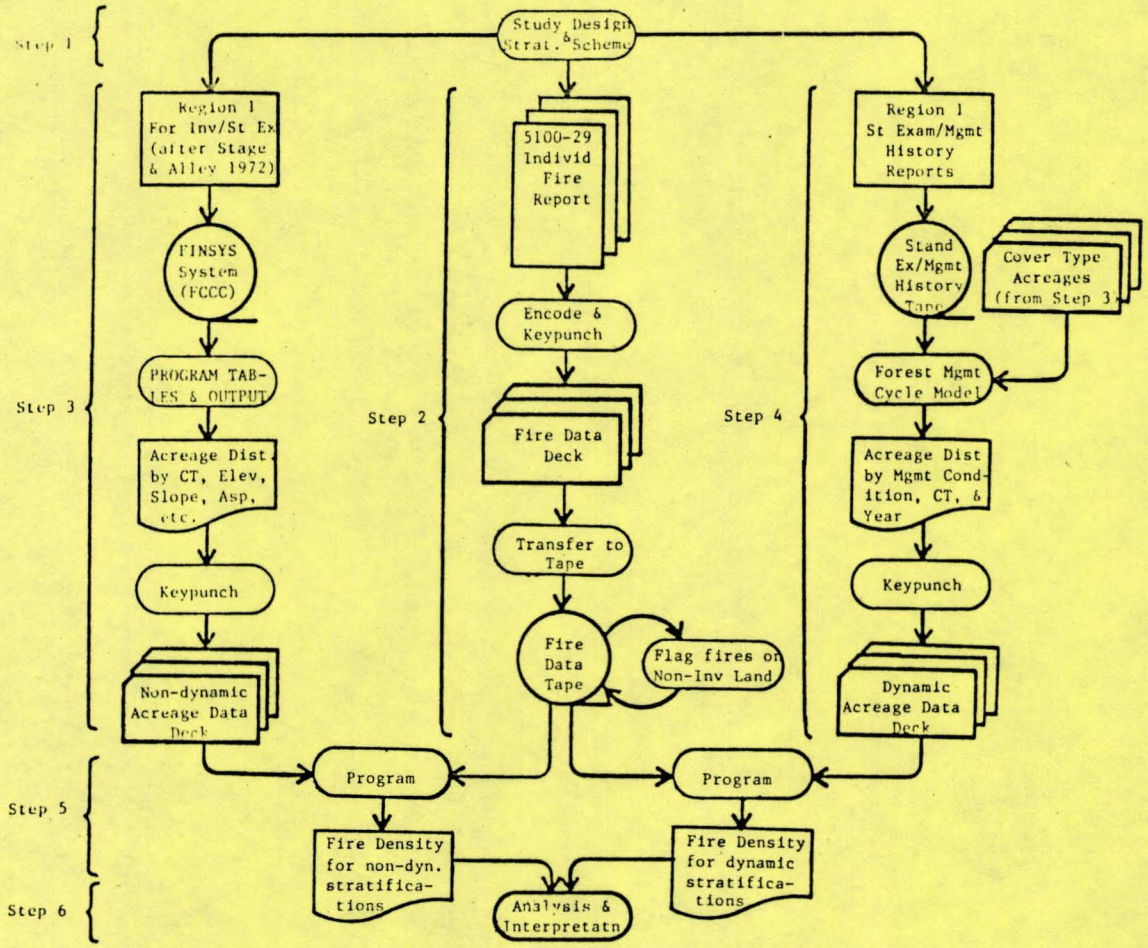
Summary of Management Activity by Cover Type through 1974

Kootenai National Forest

Cover Type	Harvests	Hazard Reduction Site Preparation	Regeneration wo. Site Preparation	Regeneration with Site Preparation	Wildfire
Ponderosa Pine	26384	13467	7101	7118	1558
Douglas-fir	57351	26643	6070	9289	768
Lodgepole Pine	19484	9465	3104	4304	2349
Engelmann Spruce	44652	25561	9085	20781	452
Western Larch	73065	42220	13430	22701	3555
Grand Fir	4780	2984	559	2019	60
Cedar - Hemlock	9176	2740	2051	1444	99
Subalpine Types	20930	9492	5663	6270	2441
Western White Pine	4879	1923	465	812	727
Other/Unknown	4296	1854	23	107	130
Total on Record	264997	136349	47551	74845	12139

Figure 2

Methodology for Computing Forest Fire Densities



Study Results

Forest Cover Type Lightning Fire Density

Ten forest cover type classes were recognized based upon species plurality as per the Stage 1 inventory procedure. The canopy types within each class are:

1)	ponderosa pine	:	ponderosa pine
2)	Douglas-fir	:	Douglas-fir
3)	lodgepole pine	:	lodgepole pine
4)	Engelmann spruce	:	Engelmann spruce
5)	western larch	:	larch - Douglas-fir larch - ponderosa pine - Douglas-fir
6)	grand fir	:	grand fir - larch - Douglas-fir
7)	cedar - hemlock	:	western red cedar western hemlock
8)	subalpine types	:	subalpine fir - Engelmann spruce mountain hemlock - subalpine fir subalpine larch - subalpine fir - lodgepole pine - whitebark pine whitebark pine - limber pine
9)	other stocked cover types	:	western white pine
10)	nonstocked	:	grass - shrub Pacific yew - juniper noncommercial forest - nonforest

No hardwood cover types were inventoried on the Kootenai National Forest.

Ponderosa pine had the highest lightning fire occurrence density of all cover type classes, 330.7 fires per million acres per year (Table 3), followed by grand fir (91.0) and spruce (73.5) cover types. Douglas-fir and lodgepole pine had the lowest occurrence densities, 15.6 and 13.8, respectively. All stocked forest lands averaged 34.3 fires/mm acres/year, while nonstocked sites averaged one-tenth the occurrence density. Figure 3 ranks the cover types by fire occurrence and fire occurrence density.

Table 3

Kootenai National Forest

Lightning Fire Density by Cover Type

1960 - 1974

Cover Type Class	Forest Acres Est Total	Forest Acres St Dev	Fire Occurrence No/Yr	Fire Occurrence St Dv	Occurrence Density N/mmAc/Yr	Occurrence Density St Dv	Acres Burned No/Yr	Acres Burned St Dv	Acres Burned Density Ac/mmAc/Y	Acres Burned Density St Dv	Acres/Fire Mean	Acres/Fire Median
Ponderosa Pine	45765.7	6070.2	15.1	8.9	330.7	193.5	23.4	45.1	510.7	986.3	1.5	0.2
Douglas - fir	460416.2	44915.7	7.2	5.7	15.6	12.3	4.8	11.5	10.4	25.0	0.7	0.2
Lodgepole Pine	577934.1	42877.4	8.0	7.0	13.8	12.1	34.7	66.6	60.1	115.3	4.3	0.2
Engelmann Spruce	59835.9	15743.8	4.4	4.2	73.5	70.8	156.6	588.5	2616.9	9834.4	35.6	0.2
Western Larch	308655.4	38369.3	11.6	8.3	37.6	26.9	4.7	5.8	15.2	18.7	0.4	0.2
Grand Fir	38095.2	14482.6	3.5	3.8	91.0	99.6	4.6	13.1	120.4	343.1	1.3	0.2
Cedar - Hemlock	122261.2	30122.9	4.9	3.3	39.8	26.9	5.8	12.4	47.3	101.4	1.2	0.2
Subalpine Types	208007.6	34572.2	7.9	6.5	38.1	31.4	152.9	498.2	735.3	2394.9	19.3	0.2
Other Stockable	19218.6	7887.0	0.6	1.0	31.2	51.3	0.2	0.4	12.1	22.9	0.4	0.2
Total Stockable	1840190.0	12.0	63.2	39.2	34.3	21.3	387.7	741.9	210.7	403.1	6.1	0.2
Nonstockable	411530.8	7.2	1.5	1.5	3.7	3.7	0.6	1.0	1.5	2.5	0.4	0.2
Inventory Total	2251720.8	12.9	64.7	39.6	28.7	17.6	388.3	742.4	172.5	329.7	6.0	0.2

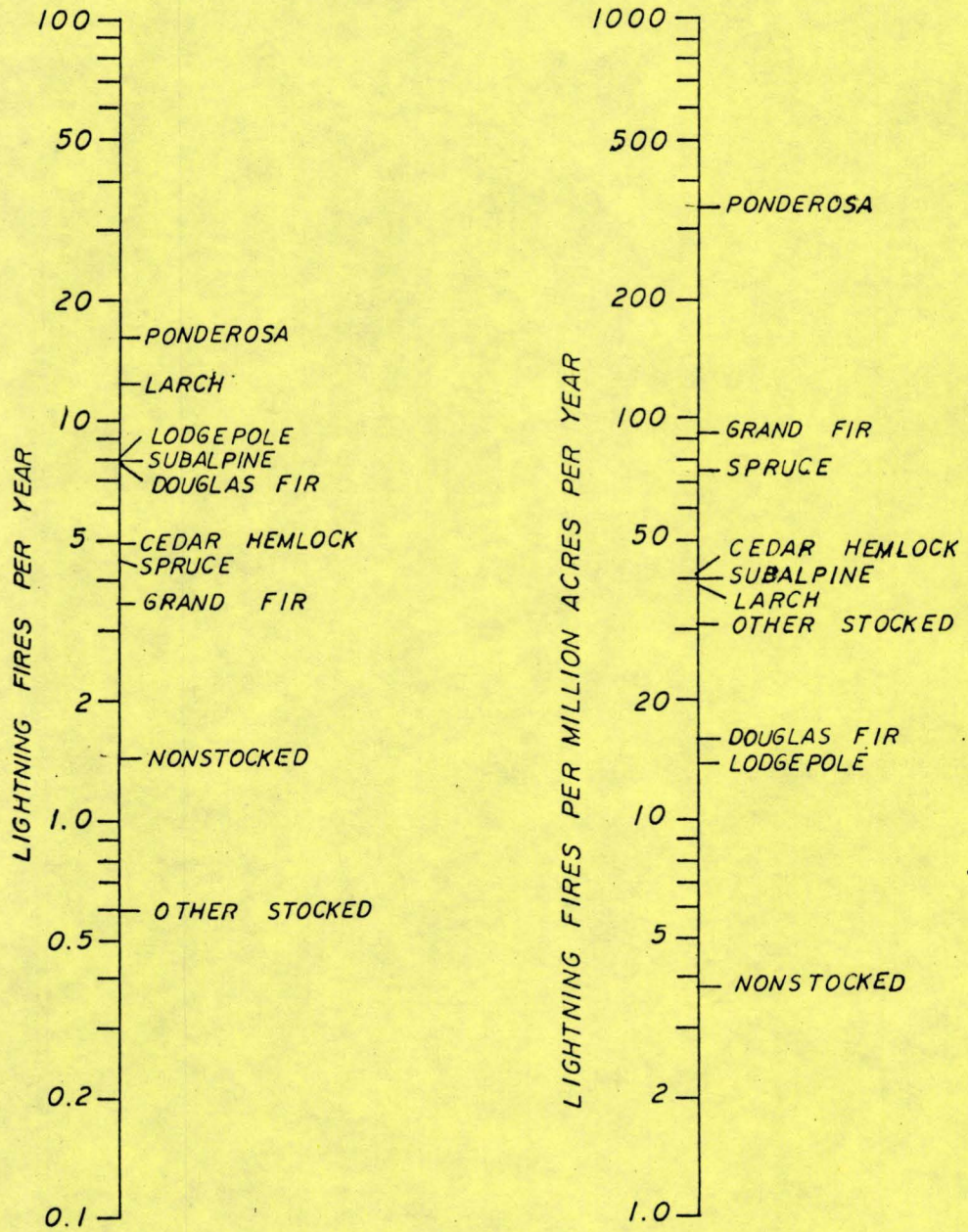
FIGURE 3

KOOTENAI NATIONAL FOREST

LIGHTNING FIRE OCCURRENCE AND OCCURRENCE DENSITY

BY FOREST COVER TYPE

1960 — 1974



SEM 1979

MISSOULA, MT

Engelmann spruce had the highest acres burned density, 2617 acres burned/mm acres/year, for a burnover rate of 382 years. Subalpine types and ponderosa pine were the next highest, with acres burned densities of 735 and 511, respectively. Engelmann spruce and subalpine covers also had the highest mean fire sizes; 35.6 acres for spruce, and 19.3 acres for subalpine types. The median fire size was 0.2 acres for all cover type classes. Figure 4 ranks the cover types by acres burned and acres burned density, and Figure 5 displays the cover type acreage distribution.

Stand Management Status Lightning Fire Density

The most flammable stand management condition on the Kootenai National Forest was disposed slash sites. Disposed slash fire occurrence density was 291 fires per million acres per year, or five times that of undisposed slash sites. Standing timber fire occurrence density was 30 fires/mm acres/year. It appears that stand flammability increases dramatically as it progresses through the standard management cycle from standing timber to harvested - undisposed slash to the disposed - unregenerated condition.

A different pattern emerges with respect to acres burned density and mean fire size. Undisposed slash sites have the highest acres burned density (1530 acres burned/mm acres/year) and greatest mean fire size (31.6 acres/fire). Disposed slash sites, on the other hand, have the lowest acres burned density (95 fires/mm acres/year) and mean fire size (0.3 acres/fire).

The data suggest usual hazard reduction and site preparation methods may actually increase the probability of a lightning strike becoming a reportable fire. The mechanism involved may be the conversion from heavy, compacted slash fuels which are relatively difficult to ignite, to light, flammable grass fuels. The same conversion mechanism may account for the mean fire

FIGURE 4

KOOTENAI NATIONAL FOREST

LIGHTNING FIRE ACRES BURNED AND ACRES BURNED DENSITY

BY FOREST COVER TYPE

1960 — 1974

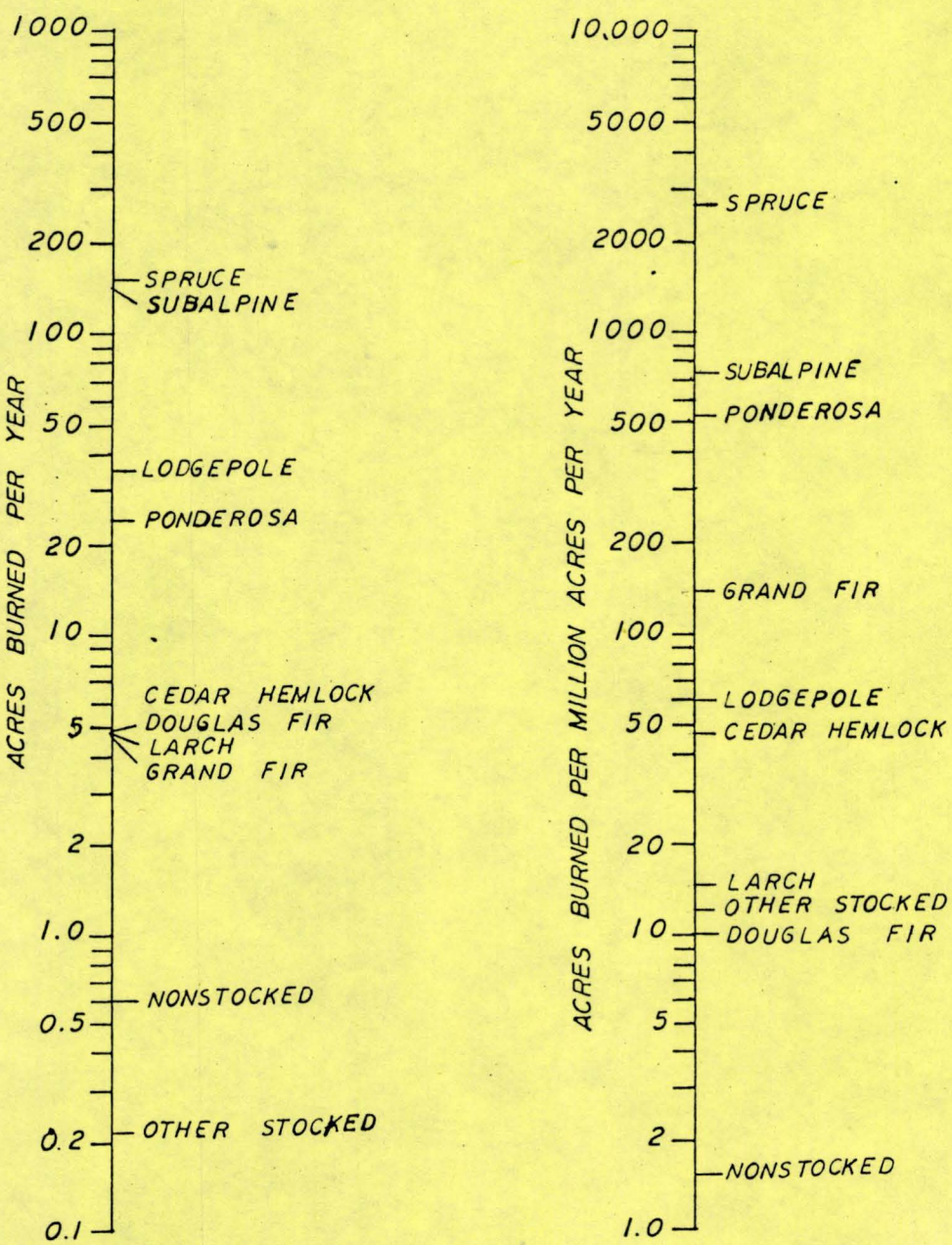


FIGURE 5

FOREST COVER TYPE AND STAND MANAGEMENT STATUS ACREAGES

KOOTENAI NATIONAL FOREST

1960 – 1974 MEANS

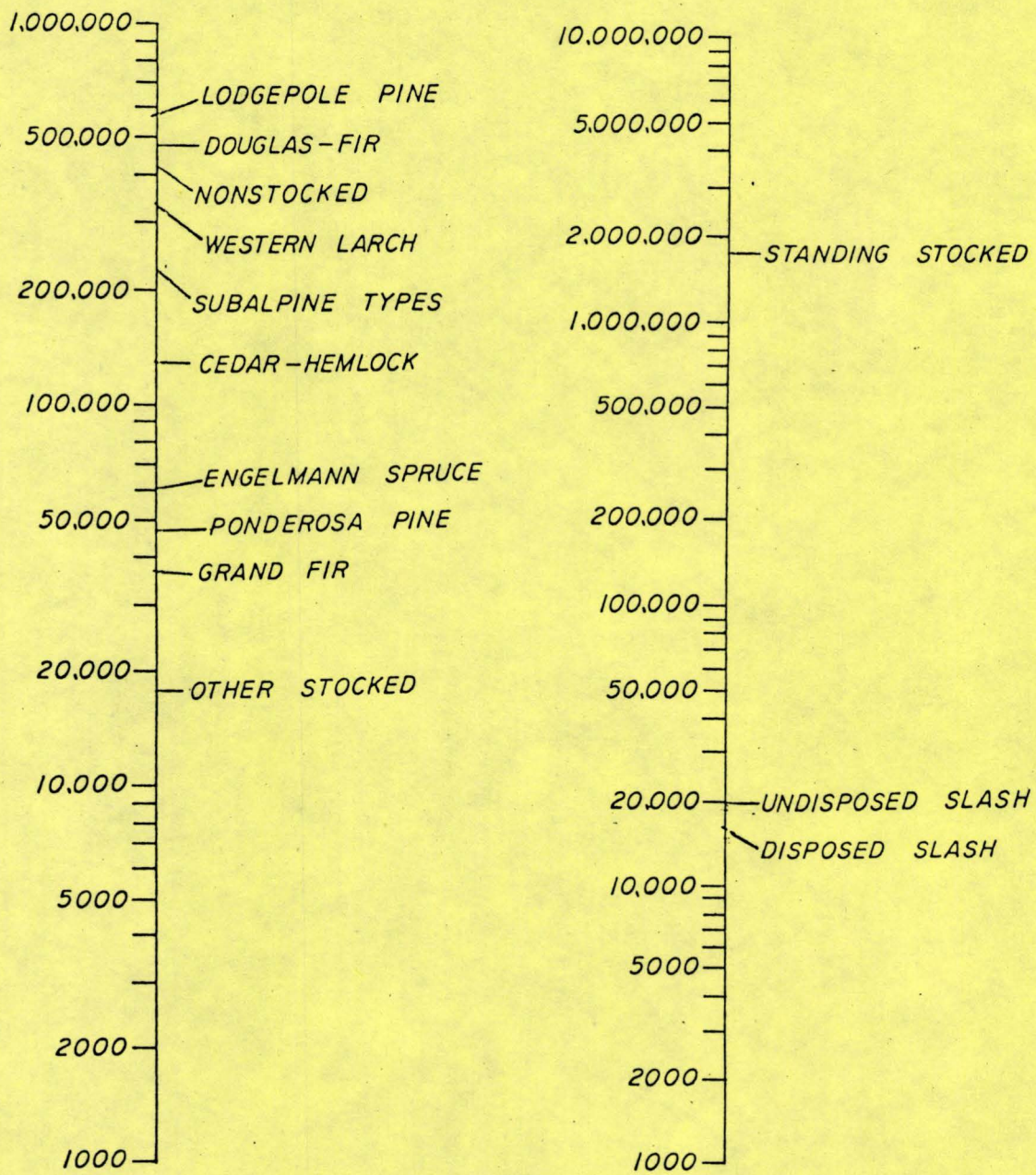


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Table 4

Kootenai National Forest

Lightning Fire Density by Management Status Class

1960 - 1974

Management Status	Forest Acres Est Total*	Forest Acres St Dev	Fire Occurrence No/Yr	Fire Occurrence St Dv	Occurrence Density N/mmAc/Yr	Occurrence Density St Dv	Acres Burned No/Yr	Acres Burned St Dv	Acres Burned Density Ac/mmAc/Y	Acres Burned Density St Dv	Acres/Fire Mean	Acres/Fire Median
Standing Timber	1742732.6	34280.7	52.3	32.0	30.0	18.3	288.5	564.5	167.8	331.4	5.5	0.2
Undisposed Slash	58002.9	19221.3	3.1	3.3	61.2	69.3	96.8	305.0	1529.7	4123.8	31.6	0.2
Disposed Slash	39454.5	15832.8	7.8	6.6	290.8	369.1	2.4	2.8	94.7	151.1	0.3	0.2
Stockable Total	1840190.0	12.0	63.2	39.2	34.3	21.3	387.7	741.9	210.7	403.1	6.1	0.2
Nonstockable	411530.8	7.2	1.5	1.5	3.7	3.7	0.6	1.0	1.5	2.5	0.4	0.2
Inventory Total	2251720.8	12.9	64.7	39.6	28.7	17.6	388.3	742.4	172.5	329.7	6.0	0.2

* Average acreage in status class from 1960 through 1974.

size and acres burned density pattern between disposed and undisposed sites. The same heavy, compacted slash fuels which are difficult to ignite, especially under moist conditions, offer considerable resistance to control once a propagating fire front has become established. Light grass fuels, while easier to ignite under moist conditions, are also easier to contain.

The question of which condition is more costly to manage -- undisposed sites with low occurrence density but large fire size, or disposed sites with high occurrence density but small fire size -- can only be answered by examining historical suppression costs of fires on the two status types.

Table 5 further breaks down lightning fire occurrence density into cover type and management condition classes. The pattern of increasing fire occurrence density from undisposed to disposed stand conditions is exhibited by all forest cover types. The acres burned density, while higher on disposed sites for all cover types together, actually drops in the disposed slash stage for ponderosa pine, Engelmann spruce, western larch, and cedar - hemlock cover types.

Figure 6 ranks the stand management status classes by fire occurrence and occurrence density, and Figure 7 ranks the classes by acres burned and acres burned density.

Elevation Band Lightning Fire Density

Lightning fire statistics were computed for five elevation bands as in Table 6. The lightning fire regime on the Kootenai National Forest appears to change around the 5000 foot elevation level. Mean annual fire occurrence density below 5000 feet is 27 fires/mm acres/year. Above 5000 feet, occurrence density doubles to 54 fires/mm acres/year. The acres burned density steadily increases with increasing elevation, making a significant jump at the 5000 foot level. Similarly, mean fire size below 5000 feet is only 2.8

Table 5

Kootenai National Forest

Lightning Fire Density by Stand Cover Type & Management Status Class

1960 - 1974

Cover Type	Standing Timber	Undisposed Slash	Disposed Slash	Cover Type Total
Ponderosa Pine	11.6	0.6	2.9	15.1
	314.2	532.2	1481.3	330.7
	11.6	10.6	1.1	23.4
	287.6	3212.3	621.9	510.7
Douglas-fir	6.1	0.3	0.8	7.2
	14.0	14.8	337.2	15.6
	4.6	0.1	0.2	4.8
	10.8	2.9	67.4	10.4
Lodgepole Pine	7.3	0.3	0.5	8.0
	12.7	76.0	156.7	13.8
	34.5	0.1	0.1	34.7
	60.3	15.2	44.1	60.1
Engelmann Spruce	2.7	0.3	1.3	4.4
	65.9	25.7	246.5	73.5
	74.8	81.3	0.4	156.6
	1711.1	6535.1	79.0	2616.9
Western Larch	9.3	0.6	1.7	11.6
	32.6	81.5	266.2	37.6
	3.1	1.2	0.4	4.7
	10.9	78.6	59.6	15.2
Grand Fir	2.9	0.4	0.1	3.5
	80.6	327.2	608.8	91.0
	4.5	0.1	0.3	4.6
	124.1	81.6	121.8	120.4
Cedar - Hemlock	3.9	0.5	0.4	4.9
	33.3	151.6	557.8	39.8
	2.3	3.4	0.9	5.8
	19.2	760.2	124.9	47.3
Subalpine Types	7.9	0.1	0.0	7.9
	39.5	12.3	0.0	38.1
	152.9	0.0	0.0	152.9
	768.6	2.5	0.0	735.3
Other Stockable Cover Types	0.6	0.0	0.0	0.6
	40.0	0.0	0.0	31.2
	0.2	0.0	0.0	0.2
	15.2	0.0	0.0	12.1
Stockable Lands Total	52.3	3.1	7.8	63.2
	30.0	61.2	290.8	34.3
	288.5	96.8	2.4	387.7
	167.8	1529.7	94.7	210.7

Table Statistics : 1960-1974 Means

Fire Frequency (Fires/Year)
Frequency Density (Fires/mm Ac/Year)
Acres Burned (Acres Burned/Year)
Acres Burned Density (Acres Burned/mm Ac/Yr)

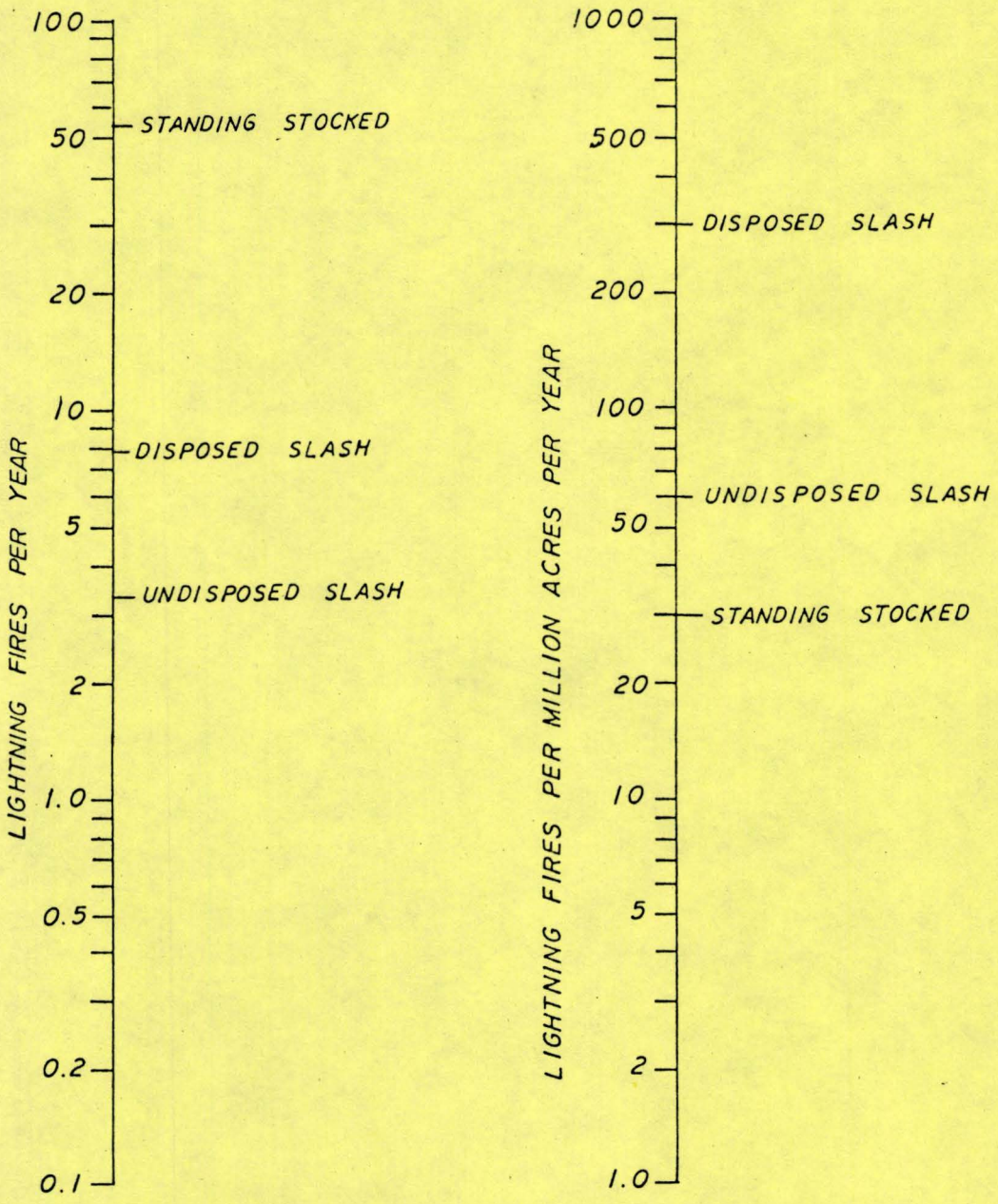
FIGURE 6

KOOTENAI NATIONAL FOREST

LIGHTNING FIRE OCCURRENCE AND OCCURRENCE DENSITY

BY STAND MANAGEMENT STATUS

1960 — 1974



SEM 1979

MISSOULA, MT

FIGURE 7

KOOTENAI NATIONAL FOREST

LIGHTNING FIRE ACRES BURNED AND ACRES BURNED DENSITY

BY STAND MANAGEMENT STATUS

1960 — 1974

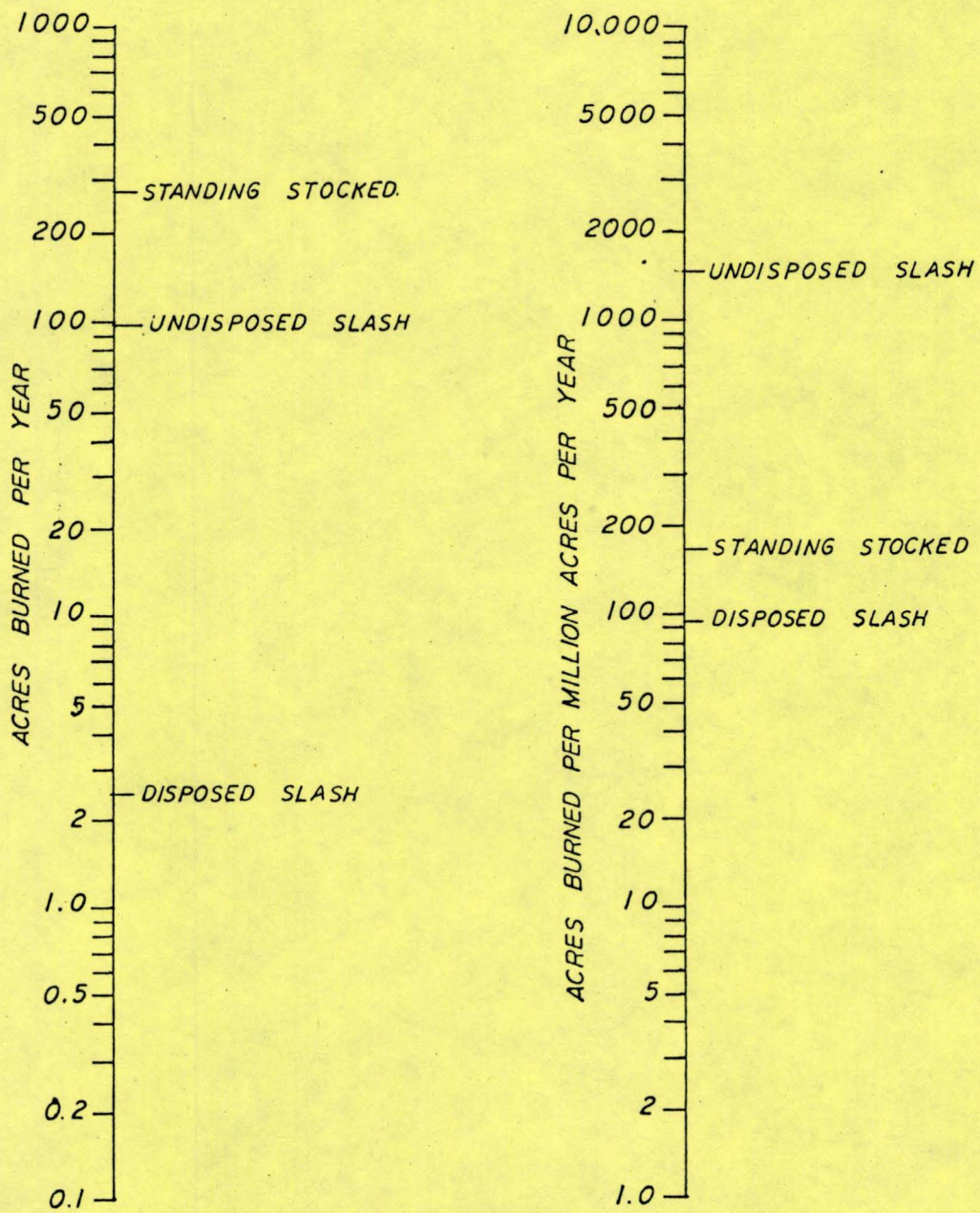


Table 6

Kootenai National Forest

Lightning Fire Density by Elevation Band

1960 - 1974

Elevation Band	Forest Acres Est Total	Forest Acres St Dev	Fire Occurrence No/Yr	Fire Occurrence St Dv	Occurrence Density N/mmAc/Yr	Occurrence Density St Dv	Acres Burned No/Yr	Acres Burned St Dv	Acres Burned Density Ac/mmAc/Y	Acres Burned Density St Dv	Acres/Fire Mean	Acres/Fire Median
2000 - 2999 Feet	142635.5	21628.0	5.4	3.1	37.9	21.8	2.8	3.6	19.4	25.5	0.5	0.2
3000 - 3999 Feet	512426.9	51902.7	15.7	11.8	30.7	23.1	21.9	41.6	42.7	81.1	1.4	0.2
4000 - 4999 Feet	892261.2	59522.5	20.6	13.1	23.1	14.7	91.2	288.1	102.2	322.9	4.4	0.2
5000 - 5999 Feet	350014.1	47503.6	17.7	12.8	50.3	36.7	218.0	563.9	622.9	1611.1	12.4	0.2
6000 Feet Plus	78042.8	16684.0	5.4	3.6	69.2	46.1	54.5	127.5	698.2	1634.0	10.1	0.2
Subtotal	1975380.5	191.8	64.7	39.6	32.8	20.1	388.3	742.4	196.6	375.8	6.0	0.2
Uncoded/Unknown	276340.3	191.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inventory Total	2251720.8	12.7	64.7	39.6	28.7	17.6	388.3	742.4	172.5	329.7	6.0	0.2

acres per fire, but increases to 11.9 acres per fire above 5000 feet. The increase in fire occurrence density may reflect a greater lightning risk at higher elevations, while the increased acres burned density and mean fire size may be a result of delayed detection and initial attack response times.

Aspect Class Lightning Fire Density

Table 7a shows lightning fire statistics for eight aspect and two slope position classes on the Kootenai National Forest. Table 7b condenses the apsects into four classes plus level and ridgetop sites. East-southeast aspects on the Kootenai National Forest had the highest values of all aspect classes for fire occurrence density (41 fires/mm acres/year), acres burned density (415 acres burned/mm acres/year), and mean fire size (10.1 acres/fire). North-northeast and south-southeast aspects had fire statistics values very similar to each other and slightly lower than the east-southeast class. West-northwest aspects had the lowest fire statistics values.

Level sites showed the lowest fire occurrence and acres burned densities of the six aspect-slope position classes in Table 7b; 4.2 fires/mm acres/year and 1.6 acres burned/mm acres/year. Ridgetops had the greatest fire occurrence density of all aspect-slope position classes, 63 fires per million acres per year, but also had the smallest mean fire size at 0.2 acres per fire.

Slope Steepness Class Lightning Fire Density

Tables 8a and 8b present lightning fire statistics for two combinations of slope steepness classes. No apparent patterns are exhibited between slope steepness and any of the lightning fire statistics. Slopes greater than 75% had the highest fire occurrence density (144 fires/mm acres/year), while slopes between 16% and 35% had the highest acres burned density (309 acres burned/mm acres/year) and mean fire size (14.8 acres/fire).

Table 7a

Kootenai National Forest

Lightning Fire Density by Aspect Class

1960 - 1974

Aspect Class	Forest Acres Est Total	Forest Acres St Dev	Fire Occurrence No/Yr	Fire Occurrence St Dv	Occurrence Density N/mmAc/Yr	Occurrence Density St Dv	Acres Burned No/Yr	Acres Burned St Dv	Acres Burned Density Ac/mmAc/Y	Acres Burned Density St Dv	Acres/Fire Mean	Acres/Fire Median
North	135985.7	29567.1	8.9	7.4	65.2	54.1	4.2	4.8	31.2	35.0	0.5	0.2
Northeast	327856.4	42258.9	5.7	4.1	17.5	12.4	82.9	303.2	252.9	924.8	14.5	0.2
East	160976.5	27163.2	6.6	4.9	41.0	30.2	2.2	1.9	13.9	11.7	0.3	0.2
Southeast	220760.2	26075.3	9.1	6.5	41.1	29.3	156.3	496.0	707.9	2246.9	17.2	0.2
South	253775.5	42737.8	10.9	7.2	43.1	28.5	84.0	285.6	331.1	1125.4	7.7	0.2
Southwest	314762.9	48013.5	9.1	5.8	29.0	18.5	35.1	62.4	111.5	198.2	3.8	0.2
West	242471.4	27061.3	7.0	4.5	28.9	18.4	21.0	70.8	86.6	292.0	3.0	0.2
Northwest	224811.1	38877.5	4.4	2.8	19.6	12.7	1.8	2.1	8.0	9.4	0.4	0.2
Level	346098.5	14879.9	1.5	1.2	4.2	3.6	0.4	0.4	1.6	1.3	0.3	0.2
Ridgetop	24222.2	9019.5	1.5	2.3	63.3	93.5	0.3	0.5	13.5	21.0	0.2	0.2
Inventory Total	2251720.8	13.0	64.7	39.6	28.7	17.6	388.3	742.4	172.5	329.7	6.0	0.2

Table 7b

Kootenai National Forest

Lightning Fire Density by Aspect Class

1960 - 1974

Aspect Class	Forest Acres		Fire Occurrence		Occurrence Density		Acres Burned		Acres Burned Density		Acres/Fire	
	Est Total	St Dev	No/Yr	St Dv	N/mmAc/Yr	St Dv	No/Yr	St Dv	Ac/mmAc/Y	St Dv	Mean	Median
North - Northeast	463842.0	47409.3	14.6	10.2	31.8	22.0	87.1	304.9	187.9	657.4	6.0	0.2
East - Southeast	381737.3	40628.8	15.7	11.1	41.0	29.1	158.5	496.0	415.3	1299.2	10.1	0.2
South - Southwest	568538.4	57519.2	20.1	12.1	35.3	21.3	119.1	283.9	209.5	499.3	6.0	0.2
West - Northwest	467282.5	50118.3	11.4	6.8	24.4	14.6	22.8	70.7	48.8	151.2	2.0	0.2
Level	346098.5	14879.9	1.5	1.2	4.2	3.6	0.4	0.4	1.6	1.3	0.3	0.2
Ridgetops	24222.2	9019.5	1.5	2.3	63.3	93.5	0.3	0.5	13.5	21.0	0.2	0.2
Inventory Total	2251720.8	13.0	64.7	39.6	28.7	17.6	388.3	742.4	172.5	329.7	6.0	0.2

Table 8a

Kootenai National Forest

Lightning Fire Density by Slope Steepness Class

1960 - 1974

Slope Steepness	Forest Acres Est Total	Forest Acres St Dev	Fire Occurrence No/Yr	Fire Occurrence St Dv	Occurrence Density N/mmAc/Yr	Occurrence Density St Dv	Acres Burned No/Yr	Acres Burned St Dv	Acres Burned Density Ac/mmAc/Y	Acres Burned Density St Dv	Acres/Fire Mean	Acres/Fire Median
0 - 15%	524490.3	35021.8	15.4	10.8	29.4	20.6	4.6	4.1	8.8	7.8	0.2	0.2
16 - 25%	546608.5	53454.7	9.3	6.9	17.1	12.6	290.9	741.4	532.2	1356.3	0.3	0.2
26 - 35%	464582.0	51216.8	11.5	8.7	24.8	18.6	18.2	39.7	39.2	85.4	7.7	0.2
36 - 45%	311180.9	37132.3	8.3	5.0	26.8	16.2	7.2	9.6	23.1	30.9	26.2	0.2
46 - 55%	224934.6	32314.1	7.2	4.6	32.0	20.4	26.8	52.5	119.1	233.4	0.9	0.2
56 - 65%	124084.5	24841.1	6.0	5.0	48.4	40.2	32.7	79.7	263.8	642.1	0.5	0.2
66 - 75%	38757.0	15686.3	4.5	3.6	115.2	93.0	6.9	13.3	178.5	343.3	2.9	0.2
76 - 85%	16208.8	8468.7	1.1	1.1	65.8	67.9	0.2	0.2	14.0	13.7	8.5	4.6
Over 85%	874.2	724.5	1.4	1.4	1601.5	1601.1	0.8	1.8	899.9	2079.7	0.3	0.2
Inventory Total	2251720.8	13.0	64.7	39.6	28.7	17.6	388.3	742.4	172.5	329.7	6.0	0.2

Table 8b

Kootenai National Forest

Lightning Fire Density by Slope Steepness Class

1960 - 1974

Slope Steepness	Forest Acres Est Total	Forest Acres St Dev	Fire Occurrence No/Yr	Fire Occurrence St Dv	Occurrence Density N/mmAc/Yr	Occurrence Density St Dv	Acres Burned No/Yr	Acres Burned St Dv	Acres Burned Density Ac/mmAc/Y	Acres Burned Density St Dv	Acres/Fire Mean	Acres/Fire Median
0 - 15%	524490.3	35021.8	15.4	10.8	29.4	20.6	4.6	4.1	8.8	7.8	0.3	0.2
16 - 35%	1011190.4	54715.1	20.9	15.1	20.6	14.9	309.1	740.8	305.7	732.6	14.8	0.2
36 - 55%	536115.5	43647.1	15.5	8.7	29.0	16.1	34.0	52.6	63.4	98.1	2.2	0.2
56 - 75%	162841.5	29364.6	10.5	7.7	64.3	47.0	39.7	85.5	243.5	525.1	3.8	0.2
75% Plus	17083.0	8517.3	2.5	2.1	144.4	122.9	1.0	1.9	59.3	110.8	0.4	0.2
Inventory Total	2251720.8	13.0	64.7	39.6	28.7	17.6	388.3	742.4	172.5	329.7	6.0	0.2

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Barrows, Jack S. 1951. Forest fires in the northern Rocky mountains. USDA Forest Service Northern Rocky Mountain Forest and Range Experiment Station Paper No. 28. 251 pp.

Stage, Albert R., and Jack R. Alley. 1972. An inventory design using stand examinations for planning and programming timber management. USDA Forest Service Intermountain Forest and Range Experiment Station Research Paper INT-26. 17 p.